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भाग 3 संरक्षी वोल्टता ट्रांसफार्मर

(दूसरा पुनरीक्षण)

Indian Standard

VOLTAGE TRANSFORMERS – SPECIFICATION

PART 3 PROTECTIVE VOLTAGE TRANSFORMERS

(Second Revision)

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Price Group 2

Instrument Transformers Sectional Committee, ETD 34

FOREWORD

This Indian Standard (Part 3) was adopted by the Bureau of Indian Standards, after the draft finalized by the Instrument Transformers Sectional Committee had been approved by the Electrotechnical Division Council.

This standard was first published in 1966 and was subsequently revised in 1978. Second revision of this standard has been undertaken to bring it in line with the latest developments at international level.

Indian Standards on voltage transformers have been published in four parts :

- Part 1 General requirements,
- Part 2 Measuring voltage transformers,
- Part 3 Protective voltage transformers, and
- Part 4 Capacitor voltage transformers.

In the preparation of this standard assistance has been derived from the following:

IEC Pub 186 (1987) Voltage transformers with Ammendment No. 1, December 1988; published by International Electrotechnical Commission.

BS 3941 : 1975 Valtage transformers with latest ammendments, published by British Standards Institution.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calcutated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

VOLTAGE TRANSFORMERS — SPECIFICATION

PART 3 PROTECTIVE VOLTAGE TRANSFORMERS

(Second Revision)

1 SCOPE

This standard (Part 3), covers additional requirements for protective voltage transformers.

2 TERMINOLOGY

For the purpose of this standard the definitions given in Part 1 of this standard shall apply.

3 GENERAL REQUIREMENTS

The protective voltage transformers shall comply with the requirements of this standard; in addition to those specified in Part 1 of this standard.

NOTES

1 The requirements of this part apply particularly to transformers which are required to have sufficient accuracy to operate protective systems at voltages that occur under fault conditions.

2 The requirements of this part shall also apply to protective secondary windings of voltage transformers.

4 ACCURACY REQUIREMENTS

4.1 All voltage transformers intended for protective purposes, shall be assigned one of the accuracy classes specified in **4.2**.

NOTE — Voltage transformers, intended for protective purposes, with the exception of residual voltage windings, may be assigned a measuring accuracy class in accordance with Part 2 of this standard.

4.1.1 The accuracy class for a protective voltage transformer is designated by the highest permissible percentage voltage error prescribed for the accuracy class concerned, from 5% of rated voltage to a voltage corresponding to the rated voltage factor. This expression is followed by the letter "P" for protective voltage transformers and "PR" for 3-phase residual voltage transformers.

4.2 Standard Accuracy Classes

4.2.1 The standard accuracy classes for protective voltage transformers are "3P" and "6P".

NOTE — Where transformers are required to have different error limits at the lower voltage limit (5% rated voltage) and at the upper voltage limit (the voltage corresponding to rated voltage factor 1.2, 1.5 or 1.9) special agreement shall be made between the manufacturer and the purchaser.

4.2.2 The standard accuracy classes for 3-phase residual voltage transformers shall be '5PR' and "10PR".

5 LIMITS OF VOLTAGE ERROR AND PHASE DISPLACEMENT FOR PROTECTIVE VOLTAGE TRANSFORMERS

5.1 The voltage error and phase displacement at rated frequency shall not exceed the values in Table 1 at 5% rated voltage, and at rated voltage multiplied by the rated voltage factor (1.2, 1.5 or 1.9) with burdens of between 25% and 100% of rated burden at a power factor of 0·8 lagging.

5.2 At 2 percent of the rated voltage, the limits of error and phase displacement with burdens of between 25% and 100% of rated burden at a power factor of 0·8 lagging shall be twice as high as those given in Table 1.

Table 1 Limits of Voltage Error and Phase Displacement

(*Clauses* 5.1 *and* 5.2)

Accuracy Class	Percentage Voltage Error	Phase Displacement
(1)	(2)	(3)
		minutes
3P	±3·0	±120
6P	±6·0	±240

6 DUAL PURPOSE VOLTAGE TRANSFORMER

6.1 Where the transformer has one secondary winding which is intended to served a dual purpose, that is, both for measurement as well as protection, it shall comply with the requirements of both Part 2 and Part 3 of this Standard.

6.2 Where the transformer has two or more separate secondary windings, one for measurement and the others for protection, having the same or different transformation ratios, they shall respectively comply with Part 2 and Part 3 of this Standard.

6.2.1 For Transformers having two or more separate secondary windings (other than residual voltage winding), because of their interdependence, the user should specify for each winding the simultaneous output ranges of the other windings at which it must fulfil the requirements of its designated accuracy class. Each winding should fulfil its respective accuracy requirement within its output range whilst at the same time the other winding has an output of any value from zero to 100% of the output range specified for the other winding.

6.2.2 If the user has not specified as required in **6.2.1** then each winding shall fulfil the requirements of its designated accuracy class with the other windings (other than residual voltage windings) simultaneously have any output between 25% and 100% of their respective rated outputs.

6.2.3 In proving compliance with **6.2.1** or **6.2.2** it shall be sufficient to test at extreme values only.

7 REQUIREMENTS FOR SECONDARY WINDINGS OF SINGLE PHASE VOLTAGE TRANSFORMERS INTENDED TO PRODUCE A RESIDUAL VOLTAGE

7.1 Rated Secondary Voltage

The rated secondary voltage of windings intended to be connected in broken delta with similar windings to produce a residual voltage shall be 110 volts, $110/\sqrt{3}$ or 110/3 volts.

NOTE — Where system conditions are such that these values of rated secondary voltages would produce a residual voltage that is too low, non preferred higher values may be used but attention is drawn to the need to take precautions for purposes of safety.

7.2 Output

7.2.1 *Rated Output*

The rated output of windings, intended to be connected in broken delta with similar windings to produce a residual voltage shall be specified in voltamperes. The value of rated output shall be chosen from the values given in **6.4** of Part 1 of this standard; but values of 25, 50 and 100 VA shall be preferred.

NOTE — For a given admittance of the secondary circuit, the power delivered by this winding under the conditions specified in this clause will normally differ from the power that it may deliver in the event of a fault when associated with two other similar windings in a three-phase system.

7.2.2 *Rated Thermal Limiting Output*

The rated thermal limiting output of a residual voltage winding for a voltage transformer with a voltage factor of 1·9 for 8 hours shall be 15, 25, 75 or 100 VA (underlined values preferred) or their decimal multiples, related to the rated secondary burden with unity power factor. In respect of such residual voltage windings, the definition in **3.23** of Part 1 shall be modified to limit the rated thermal limiting output for a duration of only 8 hours.

NOTE — Since the residual voltage windings are connected in broken delta, these windings are only loaded under fault conditions.

7.3 Accuracy Class

The accuracy class for a residual voltage winding shall be 6P as defined in **4.1.2**, **4.2.1** and **5**.

NOTES

1 If a residual voltage winding is used for special purposes, other standard accuracy class in accordance with **4.2.1** can be agreed between manufacturer and purchaser.

2 If the residual voltage winding is used only for damping purposes, an accuracy class designation is not necessary.

8 REQUIREMENTS FOR RESIDUAL VOLTAGE THREE PHASE TRANSFORMERS

8.1 Rated Residual Voltage

The rated residual voltage of a 3 phase residual voltage transformer shall be as follows:

a) For effectively earthed neutral-transformers	1 × rated residual voltage as defined at **7.1**
b) For isolated neutral voltage-transformers	3 × rated residual voltage as defined at **7.1**

8.2 Limits of Voltage Error and Phase Displacement

The voltage error and phase displacement, determined at the terminals of the transformers (including the effect of such fuses or resistors supplied as and integral part of a 3-phase residual voltage transformer) at rated frequency when tested in accordance with **10.2.1.1** shall not exceed the values given in Table 2 with burdens of any value between 25% and 100% of the rated burden of the residual voltage winding and at a power factor of 0·8 lagging.

Table 2 Limits of Voltage Error and Phase Displacement for Residual Voltage Transformers

(*Clauses* 8.2 *and* 10.2.1.1)

Accuracy Class (1)	Voltage Error (2)	Phase Displacement (3)
	Percent	minutes
5 PR	± 5·0	±200
10 PR	±10·0	±600

8.3 Limit of Error in Residual Voltage

The voltage at the terminals of the residual voltage winding shall not exceed 3 percent of the rated residual voltage under conditions given in **10.2.1.2**.

9 MARKING

9.1 All the relevant particulars shall be marked in accordance with **8** of Part 1 of this Standard. In case of Voltage Transformers required to meet combination of output and accuracy classes, the necessary information should also be provided.

10 TESTS

10.0 The following tests shall be carried out in addition to the tests given in Part 1 of this Standard.

10.1 Tests on Single-phase Protective Voltage Transformers

10.1.1 *Type Tests*

10.1.1.1 Temperature rise test for protective voltage transformers with residual voltage windings and voltage factor 1·9 for 8 hours.

A test shall made in general accordance with **9.5** of Part 1 to prove compliance with **7.2.2** at a voltage factor of 1·9 for 8 hours starting after the application of 1·2 times the rated voltage for a period sufficient for stable thermal conditions to be reached. The temperature rise shall not exceed the values specified in Table 3 of Part 1 by more than 10 K. The residual voltage winding(s) shall be loaded with a burden corresponding to the rated thermal limiting output and all the other winding(s) shall be loaded with their rated burden.

The voltage measurement has to be performed on the primary winding as the actual secondary voltage generally is appreciably smaller than the rated secondary voltage multiplied by the voltage factor.

10.1.1.2 *Accuracy test*

To prove compliance with **5**, type test shall be made at 2%, 5% and 100% of rated voltage and at rated voltage multiplied by the rated voltage factor, at 25% and 100% of the rated burden at a power factor of 0·8 lagging. Where transformer has several secondary windings, they shall be loaded as in **6**. A residual voltage winding shall be unloaded during tests with voltages up to 100 of rated voltage and loaded with rated burden during the test with the voltage equal to the rated voltage multiplied by the rated voltage factor.

10.1.2 *Routine Tests*

10.1.2.1 *Accuracy test*

The routine tests for accuracy are in principle the same as the type test in **10.1.1.2** but routine tests may be carried out at 100 percent of rated voltage and at 25% and 100% of rated burden at a power factor of 0·8 lagging provided it has been shown by type tests on a similar transformer that such a reduced number of tests is sufficient to prove compliance with **5**.

10.2 Tests on Three-phase Residual Voltage Transformer

10.2.1 *Type Test*

10.2.1.1 *Accuracy tests*

Residual voltage transformers shall be tested for compliance with the requirements of Table 2 under the following conditions:

a) For transformers having a voltage factor not exceeding 1·5, the connection of the test circuit shall be as given in Fig. 1a. The voltage error and phase displacement shall be determined at such a supply voltage that 150% of the rated primary line to earth voltage appears between the non-short circuited line terminals and the star point terminal of the primary winding and with burdens equal to 25% and 100% of the rated burden of the residual voltage winding.

b) For transformers having a voltage factor of 1·9, the connections of the test circuit shall be as given in Fig. 1b. The voltage error and phase displacement shall be determinated with a balanced three-phase voltage of a value equal to 110% of rated primary (line-to-line) voltage applied to the terminals of the primary winding, and with burdens equal to 25% and 100% of the rated burden of the residual voltage winding.

c) Subject to agreement between the manufacturer and the purchaser, the transformers referred to in **10.2.1.1** (b) may be tested with circuit connection as given in Fig. 1c. The voltage error and phase displacement shall be determined with burdens equal to 25% and 100% of the rated burden of the residual voltage winding and with a single-phase supply voltage equal to 0·55 $U_p\sqrt{3}$ where U_p is the rated primary (line-to-line) voltage of the transformer.

NOTE — For three-phase transformers having three-phase secondary winding as well as a residual voltage winding the tests specified in **10.2.1.1** (a), **10.2.1.1** (b) and **10.2.1.1** (c) should be made with rated burden connected to the three-phase secondary winding, unless otherwise agreed to between the manufacturer and the purchaser.

10.2.1.2 To prove compliance with **8.2**, a balanced three-phase voltage, containing no significant third harmonics and multiples thereof and of a value equal to 120% of rated primary (line-to-line) voltage, shall be applied to the line terminals of the primary winding, the residual voltage winding being connected to a burden of 25% of its rated burden. The voltage at the terminals of the residual voltage winding shall not exceed 30% of the rated residual secondary voltage.

NOTES

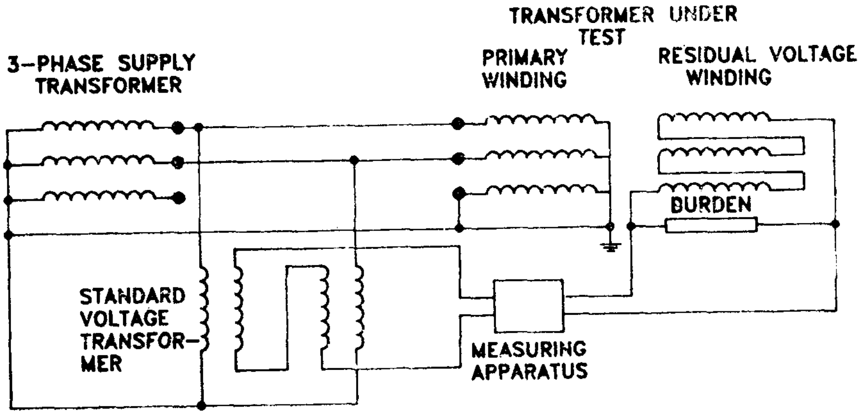
1 During this test the star points of the supply transformer and of the primary winding of the voltage transformer may be interconnected.

2 An additional three-phase secondary winding, if any shall be at no load during this test.

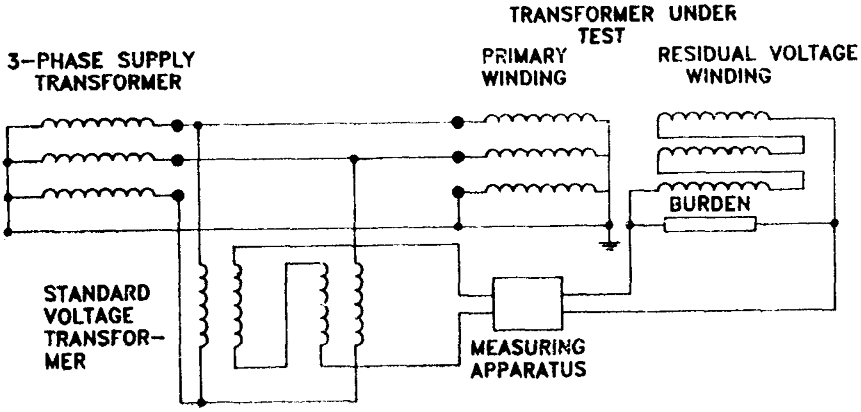
10.2.2 *Routine Test*

10.2.2.1 *Accuracy test*

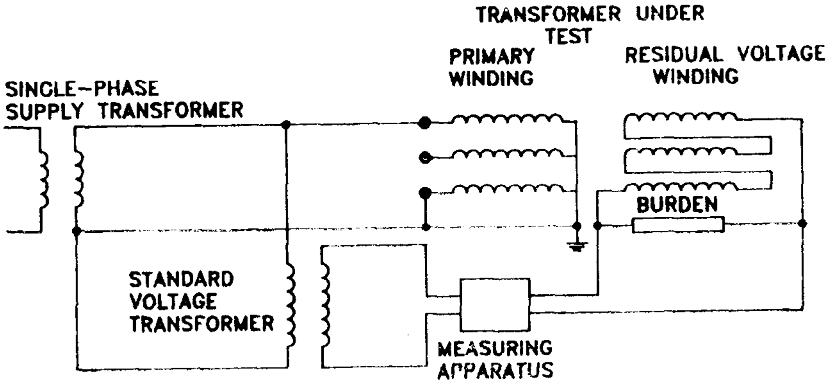
The routine accuracy test in principle is the same as the type test given in **10.2.1.1** but routine test at only rated voltage, rated frequency, rated voltage, rated frequency, rated burden with power factor of 0·8 lagging is permissible provided it has been shown by a type test on a similar transformer that a test only at rated voltage, frequency and burden is sufficient to prove compliance with **8.2**.



1A Circuit for Accuracy Test on the Residual Voltage Winding of a Transformer having a Rated Voltage Factor not Exceeding 1.5 [*see* **10.2.1.1 (a)**]



1B Circuit for Accuracy Test on the Residual Winding of a Transformer having a Rated Voltage Factor of 19 [*see* **10.2.1.1 (b)**]



1C Alternative Circuit for Accuracy Test on the Residual Voltage Winding of a Transformer having a Rated Voltage Factor of 1.9 [*see* **10.2.1.1 (c)**]

FIG. 1 CIRCUIT FOR ACCURACY TEST

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